PostGIS WKT Raster: An Open Source alternative to Oracle GeoRaster

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First of all...

$$1 + 1 = 2$$

~~$1 \times 1 = 1$~~

Oracle GeoRaster roadmap

10gR1 (2003)	First version Interleaving Georeferencing Pyramids Raster loader, viewer and exporter
10gR2 (2005)	Raster compression/decompression GeoRaster objects in other schemas Enhaced GeoRaster tools
11gR1 (2007)	Automatic DML trigger creation SDO_GEOR_ADMIN Bitmap masks NODATA ranges Empty raster blocks Random blocking size New functions, procedures and other features
11gR2 (2009)	Java API GCP Support Raster reprojections Optimized blocking Grid interpolations Polygon-based clipping in queries New functions, procedures and other features

PostGIS WKT Raster roadmap

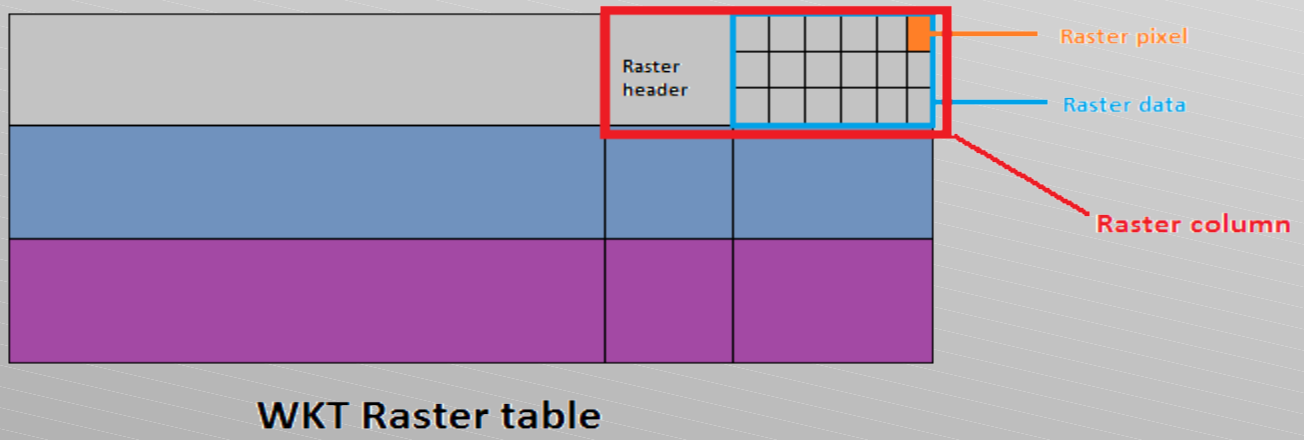
0.1.6d (Feb 2009)	First version Type definition Canonical input/output GiST index support Raster loader (gdal2wktraster)
0.1.6k (Aug 2010)	Get/Set raster properties **Intersect raster&geometries** Register out db rasters Get metadata for raster and bands Convert between world and raster coords. Set and know true nodata values Get/Set pixel values **GDAL r/o basic driver**
0.2.4 (Pred. Nov 2010)	Set raster rotation Reproject rasters Export raster to standard formats Validate raster data Topological operators MapAlgebra, reclassify... Edit raster data on db Full GDAL driver

http://trac.osgeo.org/postgis/wiki/WKTRaster/PlanningAndFunding

Main characteristics: Data type

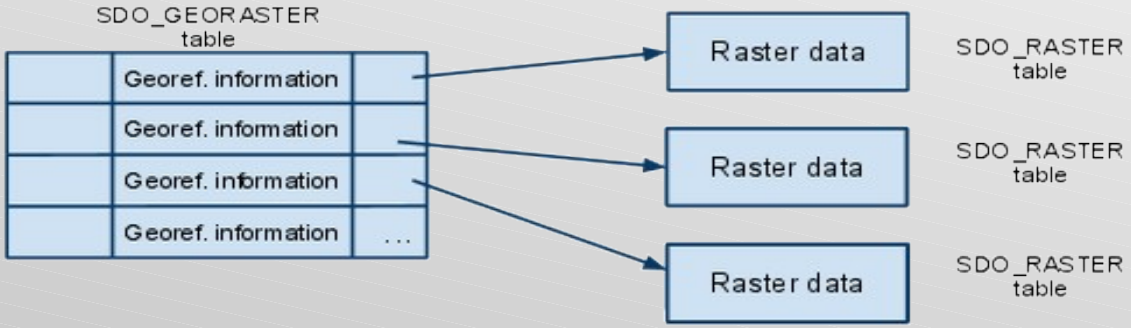
Oracle GeoRaster: 2 related data types

PostGIS WKT Raster: 1 data type



Main characteristics: Georeferencing

Oracle GeoRaster:



PostGIS WKT Raster:

Main characteristics: Indexing

Oracle GeoRaster: Creates a spatial index (R-Tree index) on the spatial extent of the GeoRaster object.

PostGIS WKT Raster: Creates a GiST index on the raster column, using convex hull.

Main characteristics: Pyramids

Oracle GeoRaster: Reduced-resolution versions of rasters can be generated using 5 resampling techniques. The pyramids are stored in the same raster data table as the GeoRaster object, with the same SRS than the original one.

PostGIS WKT Raster: GDAL-provided pyramids are generated on loading time at desired levels. The pyramids are stored in different tables than the original raster.

Main characteristics: Metadata

Oracle GeoRaster: Metadata are part of the SDO_GEORASTER object, and follow a XML schema.

PostGIS WKT Raster: The metadata is packed with the raster data, like the georeference information. Only basic metadata is stored (upper left corner, width, height,

pixel size, skew, srid and numbands)

Main characteristics: Open specs

Oracle GeoRaster: The specs for SDO_GEORASTER and SDO_RASTER objects are open. This is really important, to allow third party tools to provide capabilities not implemented in the server, like spatial analysis.

PostGIS WKT Raster: Uses WKT/WKB format for representing data. Is a open specification too.

Oracle GeoRaster. First, ensure raster has accepted format or use *gdal_translate*. Then:

- **PL/SQL API:** *CREATE TABLE*, *SDO_GEOR.init*, *SDO_GEOR.importFrom*. Not very intuitive. Few formats accepted (TIFF, GIF, BMP, GeoTIFF, PNG).
- **Java loader.** Few formats accepted (TIFF, GeoTIFF, JPEG, BMP, GIF, PNG and JP2 for images. ESRI World Files, GeoTIFF and Digital Globe RPC files for georef)
- **GDAL GeoRaster driver (Ivan Lucena):** Really simple method

gdal_translate -of image.tif

PostGIS WKT Raster: All GDAL-accepted formats.

- Use python loader *gdal2wktraster*

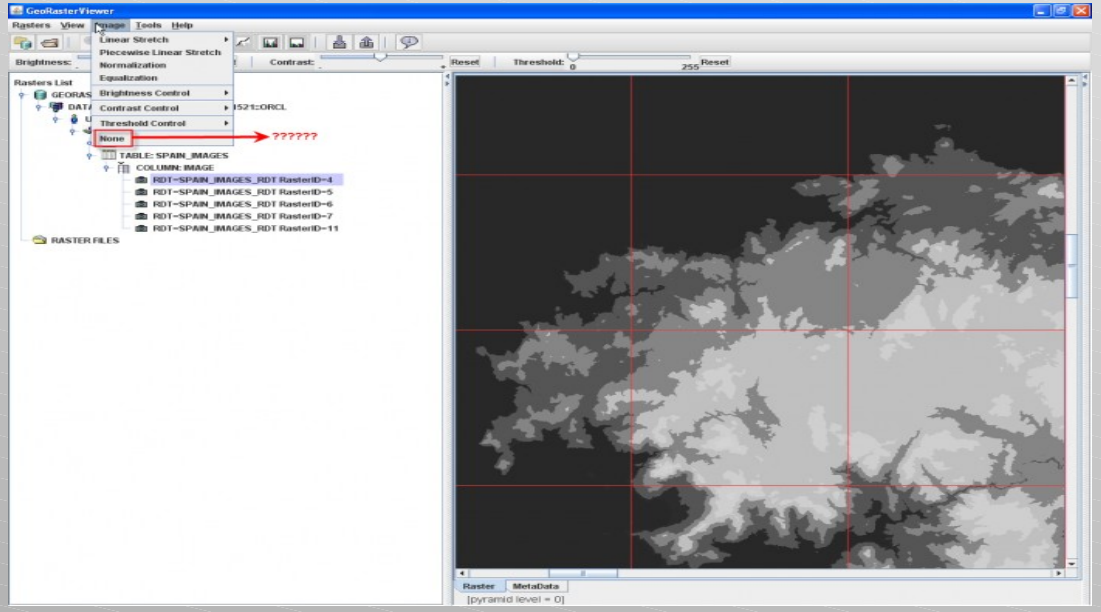
  > gdal2wktraster.py" -r C:\orcl_tut.tif -t <table> -s <srid> -k 50x50 -l -o C:\orcl_tut\srtm.sql*

  > psql -d <db> -f C:\orcl_tut\srtm.sql
- *In the future: GDAL WKT Raster driver (currently, only support WKT Raster reading).*

Basic Operations: Viewing data

Oracle GeoRaster:

- Official viewers: GeoViewer (some bugs), MapViewer.
- Lots of Spatial Partners (http://www.oracle.com/technology/products/spatial/spatial_partners_sys_inte)
- Tools via GDAL GeoRaster driver (i.e.: QGIS)



Basic Operations: Viewing data

PostGIS WKT Raster: Now, is possible to visualize WKT Raster data using **OpenJUMP** and ST_PixelAsPolygons function.

Apart from that, there are no tools allowing WKT Raster data visualization. But we have plans for developing support on:

- gvSIG
- GeoServer

Oracle GeoRaster: As when loading data...

- **PL/SQL API:** *SDO_GEOR.exportTo*. Few formats accepted (TIFF, BMP, GeoTIFF, PNG). Limited data size on 1 operation: 67 MB.
- **Java:** Few formats accepted (PL/SQL plus JPEG and GIF). Memory problems with data size up to 67MB.
- **GDAL GeoRaster driver**.

PostGIS WKT Raster:

- GDAL WKT Raster driver (all GDAL accepted formats)
- Planned: directly from-db exporting to common formats (totiff, tojpeg...)

Simple example with Oracle GeoRaster (I)

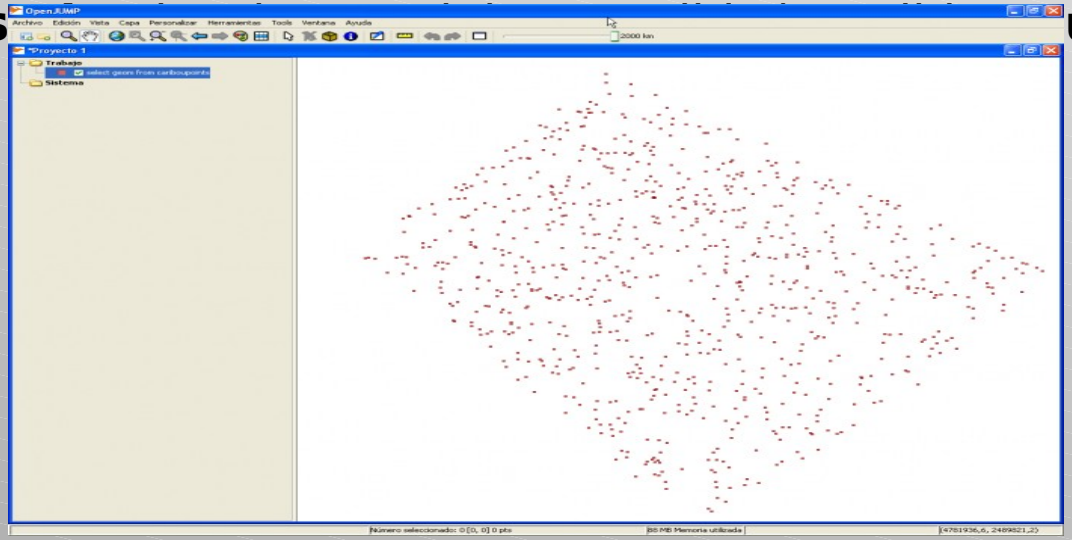
Example: Compute pixel value statistics on areas delimited by vector polygons (http://gis4free.wordpress.com/2010/09/01/oracle-georaster-part-ii/).

Step 1: Load vector data (points distribution).

Oracle Spatial only accept SDO format for input geometry data. We have to convert our shapefiles to SDO format using *sdo2shp*

```
C:\orc1_tut>shp2sdo.exe -o cariboupoints cariboupoints -g geom -t 0.5 -v
```

Tools us use only *ogr2ogr*)



Simple example with Oracle GeoRaster (II)

Step 2: Load raster data

Tools used: PL/SQL API

You can use Java loader too, but you should first reformat and reblock data

gdal_translate -of GTiff -a_srs epsg:4326 -anodata -32768 -co “TFW=YES” -co “INTERLEAVE=PIXEL”

-co “TILED=YES” -co "BLOCKXSIZE=50" -co "BLOCKYSIZE=50" image.tif image_new.tif

Insert raster data

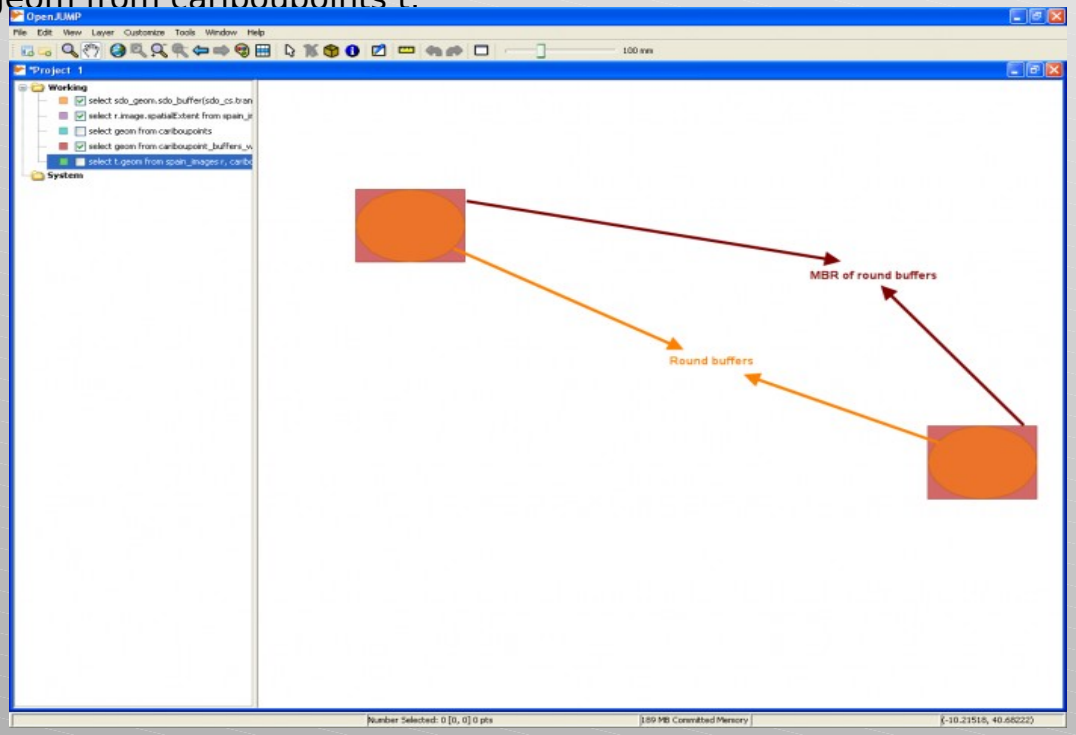
```
DECLARE
    geor SDO_GEORASTER;
BEGIN
    INSERT INTO spain_images values( 1, 'Spain_TIFF_1', sdo_geor.init('spain_images_rdt') );
    SELECT image INTO geor FROM spain_images WHERE image_id = 1 FOR UPDATE;
    sdo_geor.importFrom(geor, 'blocksize=(50,50) spatialExtent=TRUE', 'TIFF', 'file',
    'C:\orcl_tut\srtm_35_04_new.tif',
'WORLDFILE', 'FILE', 'C:\orcl_tut\srtm_35_04_new.tfw');
    UPDATE spain_images SET image = geor WHERE image_id = 1;
END;
```

Simple example with Oracle GeoRaster (III)

Step 3: Create buffers around points

Tools used: PL/SQL API

create table caribboupoint_buffers_wgs AS select t.id, sdo_geom.sdo_mbr(sdo_geom.sdo_buffer(sdo_cs.transform(t.geom, 4326), 1000, 1)) geom from caribboupoints t;



Step 4: Create indexes

Tools used: PL/SQL API

First, we must update metadata

DELETE FROM user_sdo_geom_metadata WHERE table_name = 'spain_images' AND column_name = 'IMAGE.SPATIALEXTENT';

INSERT INTO user_sdo_geom_metadata VALUES ('spain_images', 'IMAGE.SPATIALEXTENT', SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', -180, 180, .00000005), SDO_DIM_ELEMENT('Y', -90, 90, .00000005)), 4326);

Now, create the index

DROP INDEX spain_images_sidx;

CREATE INDEX spain_images_sidx ON spain_images(image.spatialExtent) INDEXTYPE IS mdsys.spatial_index;

Same operation with vector buffers

DELETE FROM user_sdo_geom_metadata WHERE table_name = 'cariboupoint_buffers_wgs' AND column_name = 'geom';

INSERT INTO user_sdo_geom_metadata VALUES ('caribouppoints_buffers_wgs', 'geom', SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', -180, 180, .00000005), SDO_DIM_ELEMENT('Y', -90, 90, .00000005)), 4326);

DROP INDEX spain_images_sidx;

CREATE INDEX caribouppoints_buffers_wgs_gidx ON caribouppoints_buffers_wgs(geom) INDEXTYPE IS mdsys.spatial_index;

Simple example with Oracle GeoRaster (V)

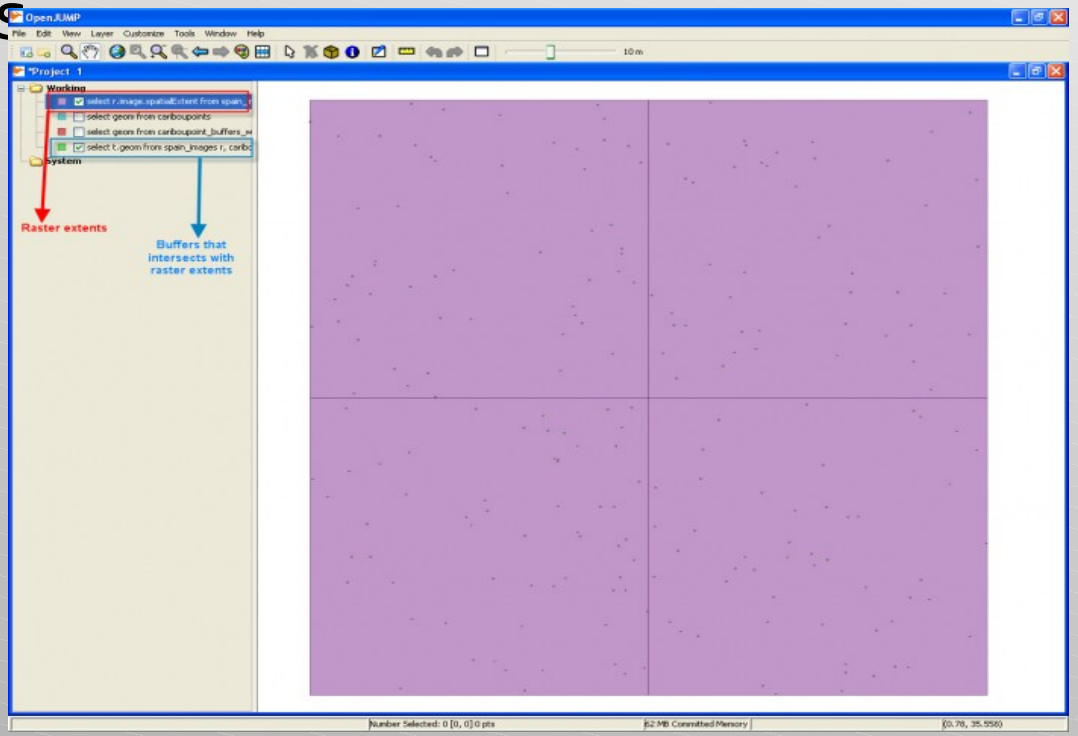
Step 5: Compute statistics. The mean elevation of the raster in areas intersected by vector buffers.

Tools used: PL/SQL API

Time: About 5 mins

To avoid a big amount of PL/SQL code, we remark the important points:

- We use the buffers to intersect the raster data extents.
- We compute raster statistics by *SDO_GEOR.generateStatistics*, using as sampling window the intersecting buffers.



Simple example with Oracle GeoRaster (VI)

Conclusions

- As we can only intersect vector data with MBR of raster data, not with the raster data itself, we could compute statistics in raster parts with no data.
- The intersection process was really fast, because we don't intersect vector with real data, but with MBR of the data.

Why? Because Oracle GeoRaster was created primarily for raster data storage, not for raster data analysis.

Simple example with PostGIS WKT Raster (I)

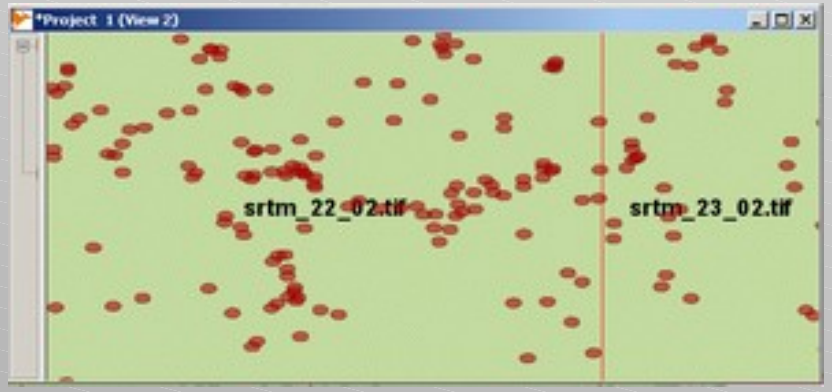
The same example (http://trac.osgeo.org/postgis/wiki/WKTRasterTutorial01)

Step 1: Load vector data (points distribution).

PostGIS only accept shapefiles as input data. We use them

```
>"C:/Program Files/PostgreSQL/8.4/bin/shp2pgsql" -s 32198 -I C:\Temp\TutData\caribou points.shp > C:\Temp\TutData\caribou points.sql
>"C:/Program Files/PostgreSQL/8.4/bin/psql" -f C:\Temp\TutData\caribou points.sql tutorial01
```

Tools used: shp2pgsql (possible to use *gr2ogr*)



Simple example with PostGIS WKT Raster (II)

Step 2: Load raster data

Tools used: *gdal2wktraster, psql*

```
>"C:/Program Files/PostgreSQL/8.4/bin/gdal2wktraster.py" -r C:\Temp\TutData\SRTM\tif\*.tif -t srtm_tiled -s 4326 -k 50x50 -I > C:\Temp\TutData\SRTM\srtm.sql
```

```
>"C:/Program Files/PostgreSQL/8.4/bin/psql" -f C:\Temp\TutData\SRTM\srtm.sql tutorial01
```

Step 3: Create buffers around points

```
CREATE TABLE caribou point_buffers_wgs AS
SELECT id, ST_Transform(ST_Buffer(the_geom, 1000), 4326) AS the_geom
FROM caribou points;
```

Tools used: PgSQL API

Note: The buffers are round, not rectangular. This is because Oracle GeoRaster only accepts rectangular sampling windows. But now, it's not necessary.

Simple example with PostGIS WKT Raster (III)

Step 4: Create indexes

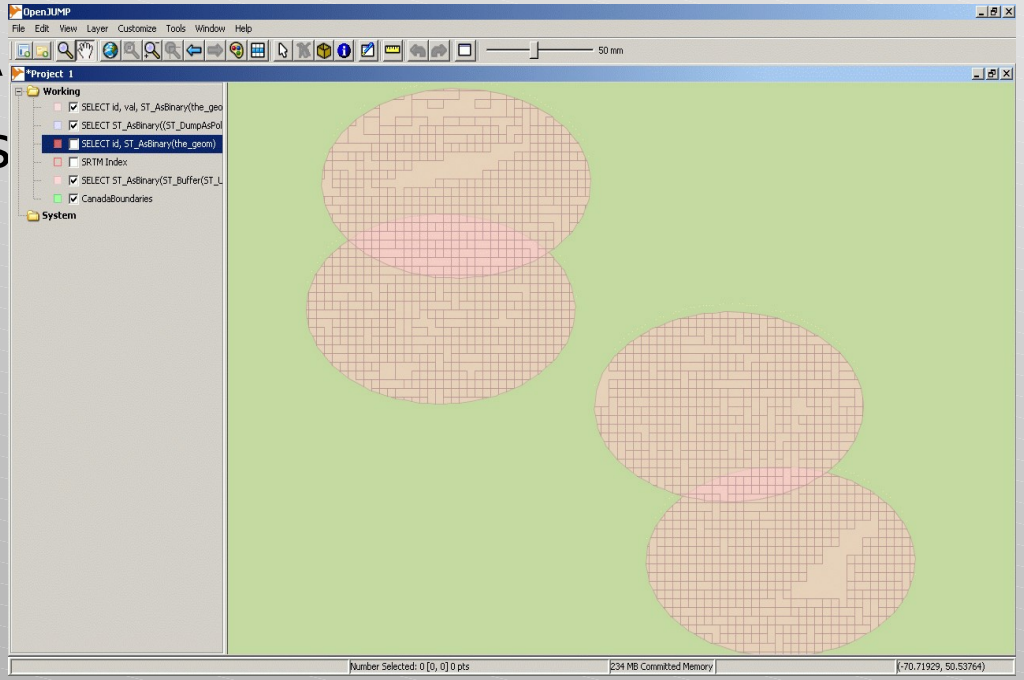
Not needed! Created when loading data.

Step 5: Compute statistics. The mean elevation of the raster in areas intersected by vector buffers.

Tools used: pgSQL A

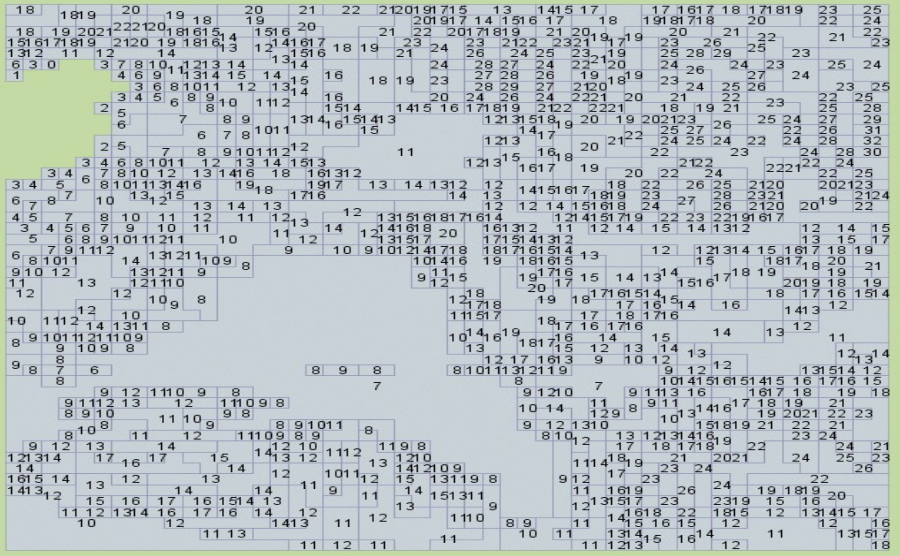
Time: About 10 mins

Note: We really intersect raster data with vector data. And the raster data is first polygonized to be intersected with buffers.



Conclusions

- Now we can really intersect vector data with raster data, not with the raster MBR. The intersection function is the first one of a set of spatial analysis functions that will work seamless with vector and raster data



Evaluation Matrix

Requirements	Oracle GeoRaster	PostGIS WKT Raster
Specific Data Type	SDO_GEORASTER	WKT Raster
Multidimensional Support	Up to 3	Up to 3
Georeferencing	Fullfilled	Fullfilled
Image pyramids	Fullfilled	Fullfilled
Partitions	Only regular	Only regular
Raster compression	Fullfilled	Fullfilled
Scan order	Not Fullfilled	Not fullfilled
Analysis capability	Not fullfilled	Fullfilled (+ r&v)
Slicing	Only get 1 layer	Only get 1 layer, planned
Subsetting	Fullfilled	Not Fullfilled (planned)
Content-based search	Using vector MBR	Partially (topological planned)
Spatial Indexing	Fullfilled (over MBR)	Fullfilled (over cells)
Open specification	Fullfilled	Fullfilled

Credits

Screenshots & tutorial: Pierre Racine

Evaluation Matrix: Damon Riga Noktula (“Server-based Raster Operations for Spatio-temporal Application in

Raster Database using Oracle GeoRaster”), based on Peter Bauman's & others criteria.

Thanks!

http://trac.osgeo.org/postgis/wiki/WKT Raster